Calibration of Aeronomy Laboratory 915 MHz and 2835 MHz profilers for TEFLUN-A

The reflectivities determined for the AL 915 MHz and 2835 MHz profilers operating during TEFLUN-A are described in this document. The reflectivities for the 915 MHz profiler are adjusted so that the lowest recovered range gate agrees with the surface JOSS disdrometer. The 2835 MHz profiler reflectivities are adjusted so that they agree with the 915 MHz when it is believed that the radome is unaffected by attenuation due to water on the radome.

Adjustment to 915 MHz ALRC

The only day during TEFLUN-A with a significant amount of surface precipitation recorded by the JOSS disdrometer was on 18 April 1998. A total of approximately 14 mm of rain was accumulated on that day. Only the data from 18 April 1998 are used in the following calculations. The reflectivity for JOSS disdrometer observations were calculated for each minute of the day. It is assumed that these reflectivities are 'truth', and that the profiler reflectivities will be adjusted to agree with these values. The adjustment will be to remove any bias between the JOSS disdrometer reflectivity and the reflectivity from lowest possible profiler range gate.

On 18 April 1998, the profiler was operating in the 105 meter pulse length mode, collecting two profiles every minute. One profile started at the beginning of the minute, and the second profile began 30 seconds after the minute. The profiler reflectivities were averaged into one minute values to form a time-height data set with similar temporal resolution as the disdrometer data set. A lag correlation was performed between the disdrometer reflectivity and the profiler reflectivity determined from the third range gate (altitude of 422 meters above sea level). The best correlation occurred when the disdrometer observations are lagged by one minute (one minute resolution). The disdrometer observations are shifted in time by one minute so that the best temporal correlation was achieved.

The original, laboratory determined ALRC (Aeronomy Laboratory Radar Constant) had a value of 26.9. The scatter plots of the difference in reflectivities (profiler - disdrometer) for the third range gate is shown in Figure 1. For disdrometer reflectivities greater than 20 dBZe, the mean and median differences are calculated and are also plotted in the figures. The mean difference is -2.65 and the median difference is -2.61 dBZe. The interpretation of this figure is that the profiler reflectivity is 2.61 dBZe (in the median) less than the disdrometer reflectivity.

Similar plots and calculations shown in Figure 1 were made for the first 5 range gates and the mean and median differences are listed in Table 1. The smallest difference relative to the disdrometer occurs in the third range gate. Thus, it can be assumed that the profiler is completely recovered by the third gate. With the assumption that the third gate has completely recovered, the differences between the surface and fourth and fifth range gates can be attributed to the time-space ambiguity as well as natural variability between the surface and these radar pulse volumes.

The mean and median differences for the third range gate (the first completely recovered range

gate) are within the standard deviation of the differences at this range gate. Therefore, the profiler reflectivity should be increased by approximately 2.6 dBZe to remove the bias between the disdrometer and profiler. This offset means that the ALRC should be increased by a factor of 1.82 (10^(2.6/10)), resulting in a new ALRC of 49.0.

The differences in reflectivities between the third and neighboring range gates are also listed in Table 1 for reference. Note that in the mean , the second range gate is 0.91 dBZe (0.61 dBZe in the median) less than the third range gate. This difference is attributed to the second range gate not being completely recovered. The first range gate is also not recovered and should not be used for any meaningful reflectivity estimates. Even though the reflectivity values for the first two range gates will be provided in the ASCII data files for completeness, it is not recommended that these reflectivity values be used for quantitative analysis, only qualitative interpretations. The nonlinear effects of the non-recovered range gates are not completely understood and a simple offset may not be accurate.

The Doppler velocity and spectral width calculations are independent of the absolute calibration of the profiler. These two moments are dependent on the shape of the spectra and not the amplitude. Therefore, even though the reflectivity is incorrect for the first two range gates, the Doppler Velocity and Spectral width for these two range gates are correctly determined from the original spectra. Due to the Doppler velocity and spectra width being independent of the absolute calibration, the profiler lowest range gates are usually set below the altitude the profiler has completely recovered. This operating procedure is normal.

The new 915 MHz ALRC was determined using data only from 18 April 1998, but applied to the few other days that precipitation was observed by the profilers.

Table 1. Reflectivity Differences between Surface Disdrometer and 915 MHz profiler for TEFLUN - A, Houston, Texas, on day 18 April 1998. Profiler ALRC = 26.9.

915 MHz Profiler 105 meter pulse mode		Mean Difference (Profiler - Disdrometer) (dBZe)	Mean Difference relative to Gate #3 (dBZe)	Median Difference (915 MHz - Disdrometer) (dBZe)	Median Difference relative to Gate #3 (dBZe)
Gate #	Altitude				
1	212 m	-15.80	-13.15	-15.58	-12.97
2	317 m	-3.56	-0.91	-3.22	-0.61
3	422 m	-2.65	0.00	-2.61	0.00
4	527 m	-3.13	-0.48	-2.90	-0.29
5	632 m	-3.35	-0.70	-3.08	-0.47

Adjustment to 2835 MHz ALRC

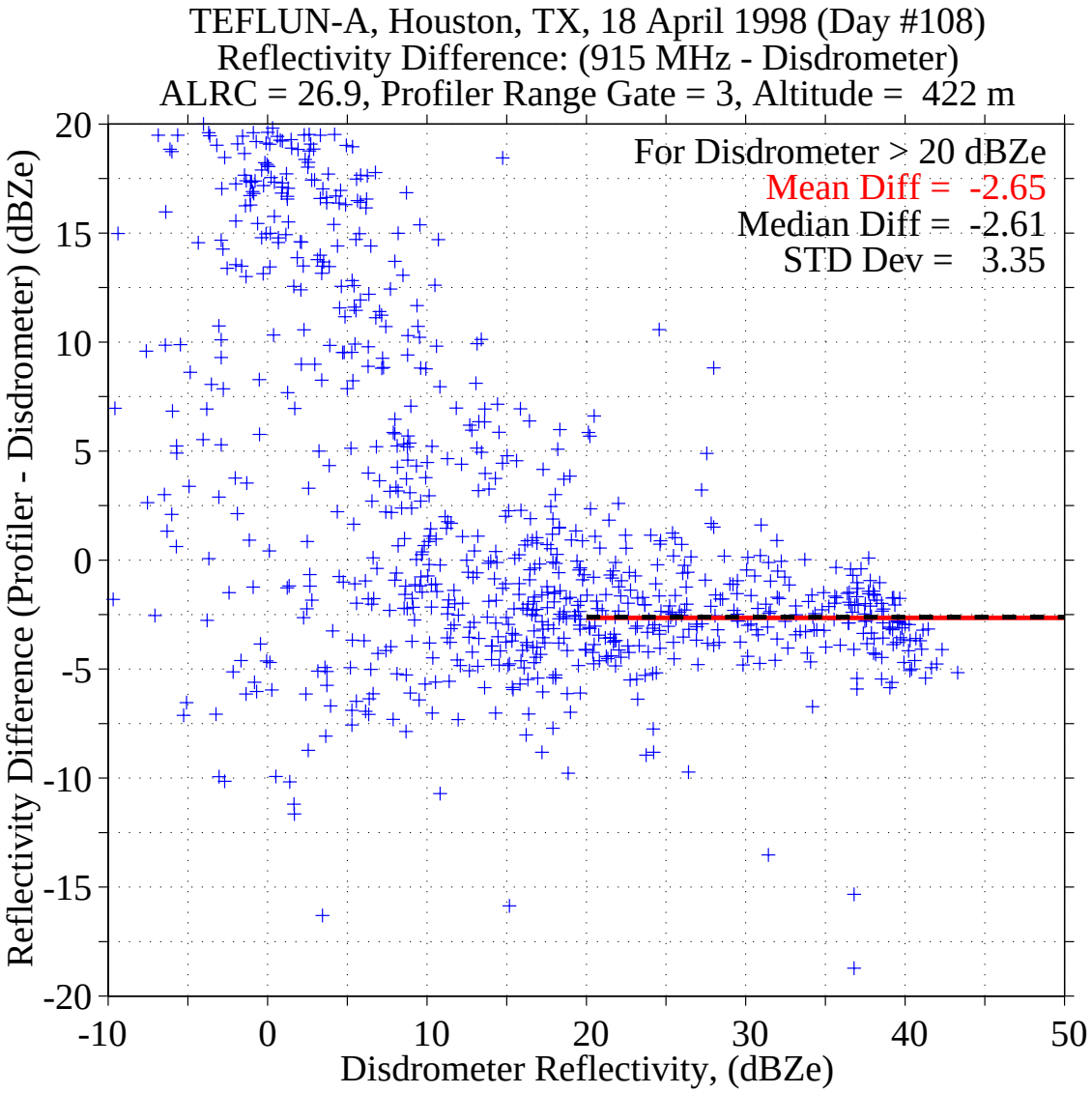
The original, laboratory derived 2835 MHz ALRC was 133.7. It was determined that there was significant attenuation to the S-band signal when the radome was wet with water during precipitation. Therefore, the 2835 MHz system gain is dependent on the conditions of the radome. The adjustment of the 2835 MHz ALRC minimizes the difference between the 915 MHz and 2835 MHz profilers when it is thought that the radome is dry.

Only the observations above the third range gate and from 18 April 1998 are used in adjusting the 2835 MHz ALRC. Figure 2 shows the difference in reflectivity (2835 MHz - 915 MHz) as a function of 915 MHz reflectivity for all observations above the second range gate for 18 April 1998. The colors are normalized so that the pixel with the most occurrences has the warmest color and the colors become cooler as the occurrences decrease. The colors change on a logarithmic scale to show detail. The mean and median difference as a function of 915 MHz reflectivity was determined using a running window of +/- 5 dBZe. The increase in difference with increasing 915 MHz reflectivity is consistent with the 2835 MHz radome being wet and attenuating the S-band signal.

The median difference in Figure 2 is used as the reference to adjust the 2835 MHz ALRC. The median difference has a nearly flat response from 10 to 20 dBZe. In this range, the median difference is approximately -5.2 dBZe. To make this portion of the median difference equal zero, the 2835 MHz ALRC should be increased by 5.2 dB or by a factor of 3.31 (calculated using: 10^(5.2/10)) resulting in a new ALRC of 442.5.

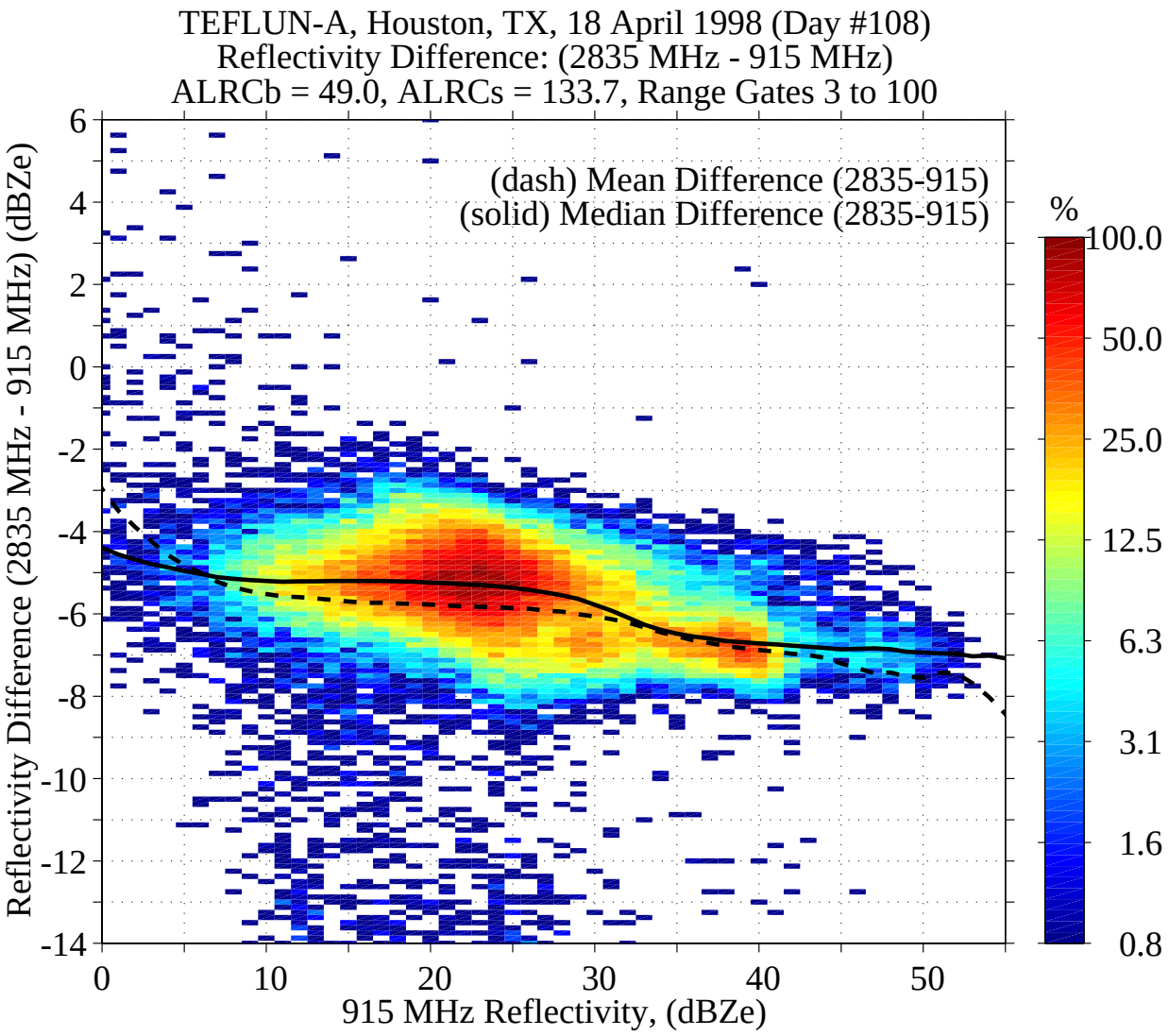
Similar to the caveat given for the reflectivities for the first two range gates of the 915 MHz profiler, it is advised to use the reflectivities from the first two gates of the 2835 MHz for qualitative purposes only. The first two range gates have not completely recovered and the true reflectivities are actually larger than the values reported in the ASCII files. These differences are not quantified in this report. The Doppler velocities and spectral widths from the first two range gates are independent of the absolute calibration and are unaffected by the recovery of the profiler.

The new 2835 MHz ALRC was determined using data only from 18 April 1998, but applied to the few other days that precipitation was observed by the profilers.



file: p_day108_zdiff_v1.m C.R. Williams: 08-Dec-1998, 23:12:18

Figure 1. Reflectivity Difference (915 MHz - Disdrometer) versus disdrometer reflectivity for the profiler third range gate and all observations on 18 April 1998. The mean difference is -2.65 dBZe (dashed line) and the median difference is -2.61 dBZe (solid line).



file: compare_915_2835_day108_v1.m C.R. Williams: 08-Dec-1998, 17:9:38

Figure 2. Reflectivity difference (2835 MHz - 915 MHz) versus 915 MHz reflectivity for all range gates from 3 to 100. The hottest color indicates the pixel with the most occurrences, and the color scale is logarithmic relative to this most populated pixel to show the details of the distribution. The mean (dash) and median (solid) difference are determined for each 1 dBZe of 915 MHz reflectivity using a +/- 5 dBZe running window.